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UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))	Attorney Docket No.	JCC 400A
	First Inventor or Application Identifier	J. Carl Cooper
	Title	Audio to Video Timing Meas. for MPEG Type Television Systems
	Express Mail Label No.	EM402714439US

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents.	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
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1. <input checked="" type="checkbox"/> * Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing) 2. <input checked="" type="checkbox"/> Specification [Total Pages <u>25</u>] (preferred arrangement set forth below) - Descriptive title of the invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D - Reference to Microfiche Appendix - Background of the invention - Brief Summary of the invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure 3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) [Total Sheets <u>2</u>] 4. Oath or Declaration [Total Pages <u>1</u>] a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. § 1.63(d)) (for continuation/divisional with Box 16 completed) i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b). * NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).	5. <input type="checkbox"/> Microfiche Computer Program (Appendix) 6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies ACCOMPANYING APPLICATION PARTS 7. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 8. <input type="checkbox"/> 37 C.F.R. § 3.73(b) Statement of Power of Attorney (when there is an assignee) 9. <input type="checkbox"/> English Translation Document (if applicable) 10. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations 11. <input type="checkbox"/> Preliminary Amendment 12. <input type="checkbox"/> Return Receipt Postcard (MPEP 503) (Should be specifically itemized) 13. <input checked="" type="checkbox"/> * Small Entity Statement(s) <input checked="" type="checkbox"/> Statement filed in prior application, Status still proper and desired (PTO/SB/09-12) 14. <input type="checkbox"/> Certified Copy of Priority Document(s) (if foreign priority is claimed) 15. <input type="checkbox"/> Other:
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16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:
☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No: 09,119,524
 Prior application information: Examiner M. Lee Group / Art Unit: 2714
 For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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**STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(b))—INDEPENDENT INVENTOR**

Docket Number (Optional)

JCC 400A

Applicant, Patentee, or Identifier: J- Carl Cooper

Application or Patent No.: _____

Filed or Issued: _____

Title: Audio to Video Timing Measurement for MPEG Type Television Signals

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

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- ☒ No such person, concern, or organization exists.
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Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

J- Carl Cooper
NAME OF INVENTOR

NAME OF INVENTOR

NAME OF INVENTOR

[Signature]
Signature of inventor

Signature of inventor

Signature of inventor

4/7/00
Date

Date

Date

**AUDIO TO VIDEO TIMING MEASUREMENT
FOR MPEG TYPE TELEVISION SYSTEMS**

4 This application is a Continuation In Part to S/N 09/119,524 filed 07/21/98 which is a
5 division of S/N 08/620,126 filed 03/21/96 which receives priority from provisional application
6 60/008,309 filed December 7, 1995, which applications are incorporated herein in their entirety
7 and for all purposes as if they had been set forth in detail.

8 The examiner's attention is called to incorrectly published U.S. Patent 5,847,769 which is
9 related to the present application by virtue of common application 08/620,126. The '769 patent
10 was withdrawn from issue. Despite the fact of the patent being withdrawn from issue it was
11 nevertheless published by the Patent Office. Applicant is of the belief that this mistakenly
12 published patent does not constitute prior art, and is not available in respect to any double
13 patenting matter or the like, but brings it to the attention of the examiner out of applicant's duty of
14 candor.

15
16 **BACKGROUND OF THE INVENTION**

17 The invention relates to measuring, maintaining and correcting synchronization between two
18 signals which suffer varying relative delays during transmission and/or storage, and in particular to
19 measuring the relative delay between multiple audio signals and an associated video signal of a
20 television type program which is compressed via MPEG or other compression method for
21 transmission and/or storage.

1 1. FIELD OF THE INVENTION

2 The present invention relates to the field of transmitting and storing multiple electronic
3 signals where synchronization of the signals is of concern. When such transmitting and storing are
4 of a nature which makes the corresponding receiving and recovering of said signals subject to
5 timing errors resulting from differing amounts of processing delays the present invention is useful
6 in measuring the relative timing errors or delays between signals with such delay measurement
7 being used as a meter of quality of the transmitting and storing and for maintaining or correction
8 of relative delays between such signals.

9
10 2. DESCRIPTION OF RELATED PRIOR ART

11 It is known in the television signal transmission field to measure and correct audio to video
12 timing errors by measuring the delay which a video signal experiences and using that measurement
13 to delay a companion audio signal by a corresponding amount.

14 U.S. Patent 4,313,135 by the present inventor shows to compare relatively undelayed and
15 delayed versions of the same video signal to provide a delay signal responsive to the delay thereof
16 and to couple that delay signal to a variable audio delay to cause the audio delay to delay the
17 companion audio signal by a corresponding amount.

18 U.S. Patents 4,665,431 and 5,675,388 by the present inventor show transmitting an audio
19 signal as part of a video signal so that both the audio and video signals experience the same
20 transmission delays thus maintaining the relative synchronization therebetween.

21 U.S. Reissue Patent RE 33,535 corresponding to 4,703,355 shows in the preferred
22 embodiment to encode in the vertical interval of a video signal, a timing signal derived from an

1 audio signal and transmitting the combined video signal and the audio signal. At the receiving
2 location the timing signal is recovered from the video signal and a new timing signal is generated
3 from the received audio signal. The two timing signals are compared at the receiving location to
4 determine the relative delay between the timing signal recovered from the video and the newly
5 generated timing signal, thus determining the relative delay between the video and audio signals at
6 the receive location. It is also suggested to put a timing signal in the audio signal.

7 U.S. Patent 5,202,761 by the present inventor shows in the preferred embodiment to encode
8 a pulse in the vertical interval of a video signal before the video signal is delayed. The encoded
9 pulse is recovered from the vertical interval of the delayed video signal. Various methods
10 responsive to the encoded pulse or the timing thereof for the undelayed video and the encoded
11 pulse recovered from the vertical interval of the delayed video are shown which enable the
12 determination of the delay, or the control of a corresponding audio delay.

13 U.S. Patent 5,530,483 by the present inventor shows determining video delay by sampling
14 an image of the undelayed video and sampling images, including the same image of the delayed
15 version of the video and comparing the samples of the undelayed image to the samples of the
16 delayed images until a match is found indicating that the undelayed image in delayed form is
17 being compared. The time lapse between the sampling of the undelayed image, and the finding of
18 the matching delayed image is used as a measure of video signal delay.

19 U.S. Patent 5,572,261 by the present inventor shows a method of determining the relative
20 delay between an audio and a video signal by inspecting the video for a speaker's mouth and
21 determining various mouth patterns of movement which correspond to sounds which are present in
22 the audio signal. The time relationship between a mouth pattern which creates a sound and the

1 problem also occurs with large time delays such as occur with storage such as by recording since
2 by definition the video is to be stored and the undelayed version is not available upon the
3 subsequent playback or recall of the stored video.

4 U.S. Patents 4,665,431 and 5,675,388 show transmitting an audio signal as part of a video
5 signal so that both the audio and video signals experience the same transmission delays thus
6 maintaining the relative synchronization therebetween. This method is expensive for multiple
7 audio signals, and the digital version has proven difficult to implement when used in conjunction
8 with video compression such as MPEG.

9 U.S. Reissue Patent RE 33,535 corresponding to 4,703,355 shows in the preferred
10 embodiment to encode a timing signal in the vertical interval of a video signal and transmitting
11 the video signal with the timing signal. Unfortunately many systems strip out and fail to transmit
12 the entire vertical interval of the video signal thus causing the timing signal to be lost. It is
13 suggested to put a timing signal in the audio signal, which is continuous thus reducing the
14 probability of losing the timing signal. Unfortunately it is difficult and expensive to put a timing
15 signal in the audio signal in a manner which ensures that it will be carried with the audio signal, is
16 easy to detect, and is inaudible to the most discerning listener.

17 U.S. Patent 5,202,761 shows to encode a pulse in the vertical interval of a video signal
18 before the video signal is delayed. This method also suffers when the vertical interval is lost.

19 U.S. Patent 5,530,483 shows determining video delay by a method which includes sampling
20 an image of the undelayed video. This method also requires the undelayed video, or at least the
21 samples of the undelayed video, be available at the receiving location without significant delay.
22 Like the '135 patent above this method is unsuitable for long distance transmission or time delays

1 resulting from storage.

2 U.S. Patent 5,572,261 shows a method of determining the relative delay between an audio
3 and a video signal by inspecting the video for particular sound generating events such as a
4 particular movement of a speaker's mouth and determining various mouth patterns of movement
5 which correspond to sounds which are present in the audio signal. The time relationship between a
6 video event such as mouth pattern which creates a sound and the occurrence of that sound in the
7 audio is used as a measure of audio to video timing. This method requires a significant amount of
8 audio and video signal processing to operate.

9 U.S. Patent 5,751,368, a CIP of 5,530,483 shows the use of comparing samples of relatively
10 delayed and undelayed versions of video signal images for determining the delay of multiple
11 signals. Like the '483 patent the '368 patent needs for the undelayed video or at least samples
12 thereof to be present at the receiving location.

13 Attempts have been made to add various timing related signals in television program
14 streams in order to maintain audio to video synchronization. In particular in MPEG systems
15 control signals such as time stamps are utilized. Unfortunately the inclusion of these signals does
16 not guarantee proper audio to video synchronization at the receive side output of the system for a
17 variety of reasons, including the fact that there are significant video delays which occur which can
18 not be tracked by the time stamps.

19

20 BRIEF SUMMARY OF THE INVENTION

21 It is an object of the invention to provide a method for measuring or maintaining the relative
22 delay of a plurality of signals which are passed through subsequent processing.

1 It is another object of the invention to provide a method of generating a marker in response
2 to a second signal which marker may be associated with a first signal in a fashion that said marker
3 is carried with said first signal through processing of said first signal.

4 It is still another object of the invention to provide a method of responding to a marker
5 which has been associated with a first signal and a marker which is provided in response to a
6 second signal whereby said markers may be utilized to determine the relative delay between said
7 first and second signals.

8 It is a further object of the invention to provide a marker in response to a signal wherein said
9 marker indicates the occurrence of particular characteristics of said signal.

10 It is a still further object of the invention to provide a system of measuring the relative delay
11 between an audio and a video signal in a television system wherein the audio and video signals are
12 subject to differing processing which creates unequal delays in said signals.

13 It is yet still a further object of the invention to provide a method of marking a first signal
14 which may be a video signal to allow relative delay measurement of said first signal and a second
15 signal which may be an audio signal after they have been processed, including use of a marker
16 generator responsive to the second signal to generate a marker upon the occurrence of one or more
17 particular characteristics of the audio, associating the marker with the video signal in a fashion
18 such that the marker will be carried with the video signal and not be adversely affected by the
19 subsequent processing thereof.

20 It is yet still another object of the invention to provide a relative delay measurement system
21 for measuring the relative delay between a plurality of signals including a first signal which is a
22 video signal and second signal which is an audio signal which signals experience unequal delays

1 due to processing thereof, the invention including use of a marker generator responsive to the
2 audio signal to generate a marker upon the occurrence of one or more particular characteristics of
3 the audio, associating the marker with the video signal in a fashion such that the marker will by
4 carried with the video signal but not be adversely affected by the subsequent processing thereof,
5 responding to the marker with the video signal after the processing to generate a first delayed
6 marker; generating a second delayed marker in response to the processed audio signal, comparing
7 the relative timing of the first and second delayed markers to determine the relative timing
8 between the processed audio and processed video signal.

9 The preferred embodiment of the invention may be used with a television signal. At the
10 transmitting location a marker is generated in response to the audio signal and is associated with
11 the video signal such that the marker is carried with the video signal in a fashion such that it will
12 not be lost or adversely affected by the expected processing of the video signal. The audio signal
13 and the marker associated video signal are stored, transmitted and/or processed and made available
14 at a later time thus becoming delayed video and audio signals.. A first delayed marker is recovered
15 from the delayed video signal and a corresponding second delayed marker is generated from the
16 delayed audio signal, with the two delayed markers compared to determine the relative delay
17 therebetween. This relative delay between these markers is responsive to and is a measure of the
18 delay between the delayed video signal and delayed audio signal.

19 Somewhat simplistically stated, the preferred embodiment of the invention operates by
20 generation of the marker at the transmit section, which may be thought of a marking the video at
21 the time of the occurrence of a known event in the audio signal. The time marker is associated
22 with the video signal such that it is carried in time with the video signal for all of the processing

1 which the video signal is to experience. After the video signal processing and any audio signal
2 processing, the same event in the audio is again marked in time, and the previously marked time
3 (relative to the video) is recovered or flagged in the received video. Since it is known that the
4 audio event and the marking of the video occurred (substantially) simultaneously at the transmit
5 location, the displacement between those events at the receive location is a measure of the audio to
6 video timing error, or the relative delay therebetween.

7 Generally, the present invention teaches measuring the relative delay between a plurality of
8 signals which have suffered differing delays due to transmission, storage or other processing. The
9 preferred embodiment of the invention includes the use of a marker which is generated in response
10 to a second signal and combined with a first signal in a manner which ensures that the marker will
11 not be lost in the expected processing of the first signal. Subsequently a first delayed marker is
12 generated in response to the marker associated with or recovered from the first signal, and a
13 second delayed marker is generated from the second signal. The first delayed marker and second
14 delayed marker are compared to determine a measure of the relative timing or delay between said
15 first signal and said second signal at said subsequent time.

17 BRIEF DESCRIPTION OF THE DRAWINGS

18 Figure 1 shows a block diagram of the preferred embodiment of the invention as used with a
19 television audio and video signal.

20 Figure 2 shows a block diagram of the marker generator 3 and 13 of the preferred
21 embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

1
2 In Figure 1 the preferred embodiment of the invention which is given by way of example, a
3 video signal 1 and an audio signal 2 are present at what will be referred to as the transmit location.
4 Either or both the video and audio signals may be in analog or digital, compressed or
5 uncompressed form, the many variations and versions of which are well known in the art. Further,
6 while the preferred embodiment is shown in respect to one video and one audio signal, it will be
7 appreciated from the teachings herein that the invention may be utilized and practiced with
8 multiple video and/or audio signals. In particular, by way of example the invention may be
9 practiced with video and stereo (2 channel), surround (4+ channel) or 5.1 channel audio systems as
10 are contemplated for the new U.S. digital and HDTV transmission standards. It is also noted that
11 the components of the invention may be implemented by analog, digital or software means or
12 combinations thereof.

13 A marker generator 3 is responsive to the audio signal, and may be responsive to the video
14 signal as indicated by the dashed line. In response to detecting the occurrence of one or more
15 particular feature or characteristic of the audio signal generates a marker. One of ordinary skill in
16 the art will recognize that element 44 of RE 33,535 may be utilized as element 3 herein. Other
17 constructions and operations of 3 will also will be known to one of ordinary skill from the present
18 teachings. The particular features, characteristics, occurrences or other event in the audio signal
19 which will result in the marker, will be referred to hereinafter as occurrences and the marker in its
20 various forms will sometimes be referred to simply as a marker, one of ordinary skill
21 understanding from the context and the teachings herein the specificity of the form or forms being
22 referred to.

1 The marker from 3 is associated with the video signal 1 in a marker associator 4. One of
2 ordinary skill in the art will recognize that element 10 of the parent specification can be used for
3 element 4 herein. Other constructions and operations of 4 will also will be known to one of
4 ordinary skill from the present teachings. The marker is preferred to be associated with the video
5 signal in a fashion that the marker will not be lost, corrupted or modified beyond use by
6 subsequent processing of the video signal. In particular it is preferred to associate the marker with
7 the video signal by including the marker within the active picture information of the video signal
8 in one of the manners disclosed in detail in the parent specification. Consequently the marker may
9 take on a form of active video, whatever form the video may be in.

10 Alternatively, the marker may be associated with the video signal by being encoded in the
11 active video in a relatively invisible fashion by utilizing one of the various watermark techniques
12 which are well known in the art. Watermarking is well known as a method of encoding the
13 ownership or source of images in the image itself in an invisible, yet recoverable fashion. In
14 particular known watermarking techniques allow the watermark to be recovered after the image
15 has suffered severe processing of many different types. Such watermarking allows reliable and
16 secure recovery of the marker after significant subsequent processing of the active portion of the
17 video signal. By way of example, the marker of the present invention may be added to the
18 watermark, or replace a portion or the entirety of the watermark, or the watermarking technique
19 simply adapted for use with the marker. It is believed that this use of watermarking techniques to
20 associate marker signals with video signals for audio to video timing purposes is novel and
21 previously unknown to those in the art. Other methods of associating the marker with the video
22 signal will be known to those of ordinary skill in the art from the teachings herein.

Also at the receiving side, another marker generator 13, similar to 3, generates a second delayed marker in response to the same audio signal occurrences in the receive section audio from 11 as the did the marker generator 3 on the transmit section in response to audio signal 2. Marker generator 13 may also be responsive to video in a fashion as previously described for 3 as shown by 19. The second delayed marker generated by 13 need not be in the same form as the marker generated by 3, but is preferred to be in the same form as the first delayed marker provided by 12.

The first and second delayed markers from 12 and 13 are coupled to the relative timing comparison 14. The relative timing comparison is responsive to these delayed markers to determine the timing between corresponding pairs thereof to determine the relative timing between them. In other words the relative timing comparison 14 determines the delay 15 of the later of the two delayed markers relative to the earlier, indicating both the magnitude of the delay and which signal is more delayed. One of ordinary skill in the art will recognize from the teachings herein that relative timing comparison 14 may operate as described with respect to element 50 of the parent specification. Other constructions and operations of 14 will also will be known to one of ordinary skill from the present teachings.

Since the first delayed marker from 12 experiences the delay of the video signal 1, and the second delayed marker from 13 experiences the delay of the audio signal 2 in their respective paths from the input of the transmit section to the output of the receive section, signal 15 is a measure of the relative delay of audio 17 and video 16 at the output of the receive section.

The relative delay 15 may be utilized for all of the uses and reasons set forth in the parent specification. In particular note that the relative delay signal 15 is useful in itself as a measure of system quality. Relative delay signal 15 may be utilized to control a delay to delay the earlier of 16

1 or 17 to place the two signals into synchronization. Relative delay signal 15 may also be utilized to
2 control a delay which is incorporated into 10 or 11 or both (or elsewhere in the system) to control
3 the delay of the earlier of the audio or video from 9 to maintain the two signals 16 and 17 in
4 synchronization. Relative delay signal 15 may also be utilized for other purposes, for example as
5 feedback to control the operation of encoder 5 or 6 or decoder 10 or 11 to minimize or otherwise
6 optimize delay or encoding and decoding of audio or video.

7 Various different embodiments of the invention herein described will be apparent to one of
8 ordinary skill in the art from the teachings herein. As an example, the marker generator 3 may be
9 responsive to the video signal as shown by 18 in order to relate the marker to the video signal, for
10 example to properly locate the marker for combination with the video signal or to relate the
11 particular feature(s) of the audio signal to timing of the video signal. In particular, it is desired
12 that the marker represent whether or not the particular features occurred in the audio signal during
13 the one or more frame or field immediately prior to the marker being combined with the video and
14 going back to the time when the immediately previous marker was combined.

15 The marker is preferred to be a binary signal which indicates that one or more of a number
16 of particular occurrences of the audio which has taken place during the preceding field(s), or is
17 currently taking place. For example, an 8 bit binary signal may be utilized with different numbers
18 corresponding to different occurrences or features. In the preferred embodiment, it is preferred that
19 the audio signal, which in the present example is assumed to have a bandwidth of 10 Hz to 20,000
20 Hz be broken up into 8 different frequency bands by bandpass filtering. Each bit of the 8 bit
21 number corresponds to the presence of audio frequencies within a particular band having energy
22 within known levels and for known time durations. For example, if no such frequencies are

1 present, the binary number 0 (0000 0000) results. If the lowest frequencies occur, the binary
2 number 1 (0000 0001) results. If the next highest frequency occurs the binary number 2 (0000
3 0010) results. If both the lowest and next highest occur a 3 results. If all frequencies occur the
4 binary number 255 (1111 1111) results. The binary number is the marker which is combined with
5 the video.

6 It is important to note that by associating the marker with the video signal in the fashion of
7 including it in the active video portion of the signal that the marker will not be lost when all of the
8 sync and blanking (or line, field and other ancillary signals if in digital form) are removed from
9 the video signal such as is done as part of the MPEG encoding process. The association of the
10 marker directly with the image carried by the video signal essentially guarantees that no matter
11 what processing, stripping or modification of ancillary portions of the video signal occurs, in
12 either analog or digital form, or conversion of scanning rates, or adjustment of usual video
13 parameters such as black, brightness and chroma, that the marker will still be detectable at the
14 receive location.

15 The transmission channel 8 is utilized in the present example to represent any common or
16 independent use or processing of the video signal 1 and audio signal 2 which may cause or result
17 in unequal delays which lead to timing difficulties. Examples of such uses include transmission,
18 storage and further processing, and in particular include storage and/or transmitting of MPEG
19 encoded audio and video signals.

20 Also it may be noted that marker generators 3 and 13 may respond to video in other forms,
21 or from other parts of the system, or may respond to other signals, for example a genlock
22 reference, in order to achieve proper operation and timing of the marker generator.

1 It may be noted that the use of the video encoder 5, audio encoder 6 and video and audio
2 combiner 7 is given by way of example, as is usual for MPEG compression and transmission
3 systems which are commonly used in today's television systems. The invention is not limited to
4 the use of such elements however and one of ordinary skill in the art will know how to practice the
5 generation of the marker and the associating of the marker with the video signal in other systems
6 from the present teachings. The combined marker and video signal from 4 and the audio signal 2
7 may very will be utilized in practicing the present invention without the added elements 5-7.

8 It will be understood that in the present example the elements 9, 10 and 11 are the receiving
9 side elements complimentary to corresponding transmitting side elements 7, 5 and 6 respectively.
10 As with 5, 6 and 7, elements 9, 10 and 11 are not required to practice the invention. In particular,
11 video from 4 may be coupled, via a transmission channel directly to element 12 and become video
12 signal 16. Similarly, audio signal 2 may be coupled via the same or different transmission channel
13 directly to 13 and become audio signal 17.

14 In the situation where the transmission channel includes storage of the audio and video
15 signals, and storage and recovery is not performed simultaneously, it is noted that a single marker
16 generator 3 may perform the function of 3 upon the storing of the signals and subsequently
17 perform the function of 13 upon the recovery of the stored signals. Other sharing of circuitry
18 between storing and recovery functions may also be had given the assumption that both are not
19 performed simultaneously.

20 Figure 2 shows the preferred form of the marker generator 3 and 13 of the preferred
21 embodiment of the invention as used with television audio signals. Audio signal 20 which may
22 correspond to 2 or the output of 11 in Figure 1 is coupled to a bank of 8 bandpass filters 21a-h

1 which are configured to pass only audio within a range of frequencies as is well known in the art.
2 The output of each bandpass filter is coupled to a comparator 22a-h respectively. The comparators
3 include hysteresis or other threshold(s) and bipolar response characteristic so that if the positive or
4 negative half cycle of bandpassed audio out of the bandpass filter exceeds a threshold amount set
5 by the hysteresis, the output of the comparator is activated. Each comparator output is respectively
6 coupled to a timing duration circuit 23a-h. Each timing duration circuit also receives a reset signal
7 from the timing circuit 26. The timing circuit 26 provides signals to the parallel to serial converter
8 24 in addition to the reset signal provided to the timing duration circuits 23. Once the timing
9 duration circuit is reset, it inspects the output signal from its respective comparator 22. If the
10 output signal from 22 is activated for an established time duration indicating the presence of audio
11 frequencies within the corresponding bandpass filter range, the timing duration circuit sets its
12 output active and holds it active until the next reset signal. The outputs of all of the timing
13 duration circuits 23 are simultaneously latched into the parallel to serial circuit 24 upon command
14 from the timing circuit 26 and shortly thereafter the reset signal to 23 is generated. Also shortly
15 after latching, the bits latched into 24 are caused to be output in serial fashion as marker 25. The
16 net effect of the circuitry is to set a bit of the timing signal active corresponding to each of the
17 bandpass audio frequencies which was present during the time period from one reset signal to the
18 next, which corresponds to the time period from the generation of one marker to the next. The
19 timing circuit 26 is responsive to the video signal to set the desired time period between markers,
20 as well as to time the output of the marker 25 so that it is associated with the video signal at the
21 correct time. This action will ensure that the marker is placed at the desired position in the video
22 signal.

1 generator, or by combining various markers each responsive to one or a small number of audio
2 signals with the various markers being combined into a smaller number or a single master marker.

3 It may be noted that many audio ICs which are used for audio graphic equalizer functions
4 contain bandpass filters which may be adapted to use in this invention. Of course it is possible to
5 implement the various elements of the marker generator, as well as the rest of the invention, in
6 analog or digital hardware, or software/hardware or combinations thereof.

7 It will be noted that the present description of the preferred embodiment of the invention is
8 given by way of example. In particular the diagrams of the preferred embodiment are presented as
9 block diagrams and do not show in detail circuitry and cooperation which would be known to
10 those of ordinary skill in the art from the teachings herein without undue experimentation. By way
11 of example it is noted that where one signal line is shown in the block diagram that multiple
12 signals may in actuality be coupled between one block and another, and although separate
13 functional blocks are shown it will be known to make different combinations, arrangements and
14 implementations in order to share elements therebetween and reduce costs. It is also noted that
15 various terms used in the specification, including generator, combiner, encoder, separator, decoder
16 and comparison, and their various tenses are intended to have broader meaning than that ordinarily
17 ascribed thereto with respect to circuit elements, and are intended to cover not only the commonly
18 understood element but the equivalent operation or function as implemented by other circuitry or
19 software/hardware combinations. One of ordinary skill in the art will know to resort to various
20 changes and modifications to the invention as described as well the combination of the invention
21 with other features functions and/or inventive concepts in order to accommodate the use of the
22 invention with particular forms of signals and otherwise to practice the invention in a fashion

- 1 which is optimized for particular application without departing from the spirit and scope of the
- 2 invention as hereafter claimed.

What is claimed is:

Claim 1. In a system having a first signal which may be a video type signal and at least one second signal which may be an audio type signal the method of marking said first signal to facilitate later determination of the timing of said first signal relative to said second signal, said method including the steps of;

marking said first signal with a marker in response to the occurrence of a particular event in said second signal said marking being such that said marker is carried with said first signal during the processing which said first signal is to experience.

Claim 2. The method of determination of the timing of a first video type signal relative to its associated audio type signal after said audio type and video type signals have been processed, said method including the steps of:

- a) identifying the occurrence of a particular event in said audio type signal;
- b) in response to said occurrence of a), marking said video type signal with a marker such that said marking is carried with said video type signal for said processing which said video type signal is to experience;
- c) after said audio type signal processing, the occurrence of the same said particular event of a) in the processed version of said audio type signal is again identified;
- d) after said video type signal processing said marking of said video type signal of step b) is detected in the processed version of said video type signal;
- e) comparing the time at which said particular event is again identified in step c) to the time of said marking of said processed version of said video type signal being detected of step d) to determine the relative timing therebetween.

Claim 3. A relative delay measurement system for measuring the relative delay between a plurality of signals which experience unequal delays due to processing thereof said plurality of signals including a first signal and a second signal, said system including:

- a) a marker generator responsive to said second signal to generate a marker upon the occurrence of particular characteristics of said second signal;
- b) a marker associator responsive to said marker of a) and said first signal for marking said first signal with said marker in a fashion such that said marker will be carried with said first signal but not adversely affected by said subsequent processing;
- c) a marker separator responsive to said first signal after said subsequent processing to detect the presence of said marker therein and in response thereto generate a first delayed marker;
- d) a marker generator, which may be the same marker generator as in a), responsive to said second signal after said subsequent processing to generate a second delayed marker;
- e) a relative timing comparison responsive to said first delayed marker and said second delayed marker to determine the relative timing therebetween.

Claim 4. The invention as claimed in any of the preceding claims wherein said first signal is a video signal and said second signal is an audio signal and said video signal is to be processed in a fashion which removes the horizontal and vertical blanking portions thereof.

Claim 5. The invention as claimed in Claim 1, 2 or 3 wherein said first signal is a video signal and said second signal is an audio signal and said signals are to be transmitted in MPEG compressed form where only the active video portion of said video signal is transmitted.

Claim 6. The invention as claimed in Claim 1, 2 or 3 wherein said first signal is a television video signal and said marking includes modifying the image portion of said video signal

Claim 7. The invention as claimed in Claim 1, 2 or 3 wherein said first signal is a television video signal and said marking includes modifying the image portion of said video signal by use of a watermarking technique.

Claim 8. In a television system where a video signal and at least one audio signal are transmitted or stored in compressed form, the method of determination the timing of said video signal relative to said audio signal after said audio signal and said video and audio signals have been compressed and subsequently decompressed, said method including the steps of:

- a) identifying the occurrence of a particular event in said audio signal prior to compression;
- b) in response to said occurrence of a), marking the image area of said video signal with a marker;
- c) after said audio signal is decompressed, the occurrence of the same said particular event of a) is again identified in the decompressed version of said audio signal;
- d) after said video signal is decompressed detecting the presence of said marker in the decompressed version of said video signal;
- e) comparing the time at which said particular event is again identified in step c) to the time of detecting the presence of said marker of step d) to determine the relative timing therebetween.

Claim 9. The method as claimed in claim 8 wherein said marking of step b) includes placing a binary number in the overscanned area of said image area.

Claim 10. The method as claimed in claim 8 wherein said marking of step b) includes encoding a binary number in said image area as a watermark.

Claim 11. The method as claimed in claim 8 wherein said event of step a) is the presence of audio signal energy within a known frequency band.

Claim 12. The method as claimed in claim 8 wherein said event of step a) is the presence of a pattern of audio signal energy within a plurality of known frequency bands.

Claim 13. The method as claimed in claim 11 or 12 wherein said audio signal energy must be greater than a known amount before being considered to be present.

Claim 14. The method as claimed in claim 8 wherein said event of step a) comprises the occurrence of a known characteristic of said audio signal within a known period of time.

Claim 15. The method as claimed in claim 8 wherein said event of step a) comprises the occurrence of a pattern of known characteristics of said audio signal within a known period of time.

Abstract

An invention for measuring, maintaining and correcting synchronization between signals which suffer varying relative delays during transmission and/or storage is shown. The preferred embodiment of the invention finds particular use in measuring the relative delay between multiple audio signals and an associated video signal of a television type program which is compressed via MPEG or other compression for a transmission and/or storage system. The invention marks the video signal at a time when a particular event in the associated audio occurs. The mark is carried with the video throughout the video processing. After processing the same event in the audio is again identified, the mark in the video identified, the two being compared to determine the timing difference therebetween.

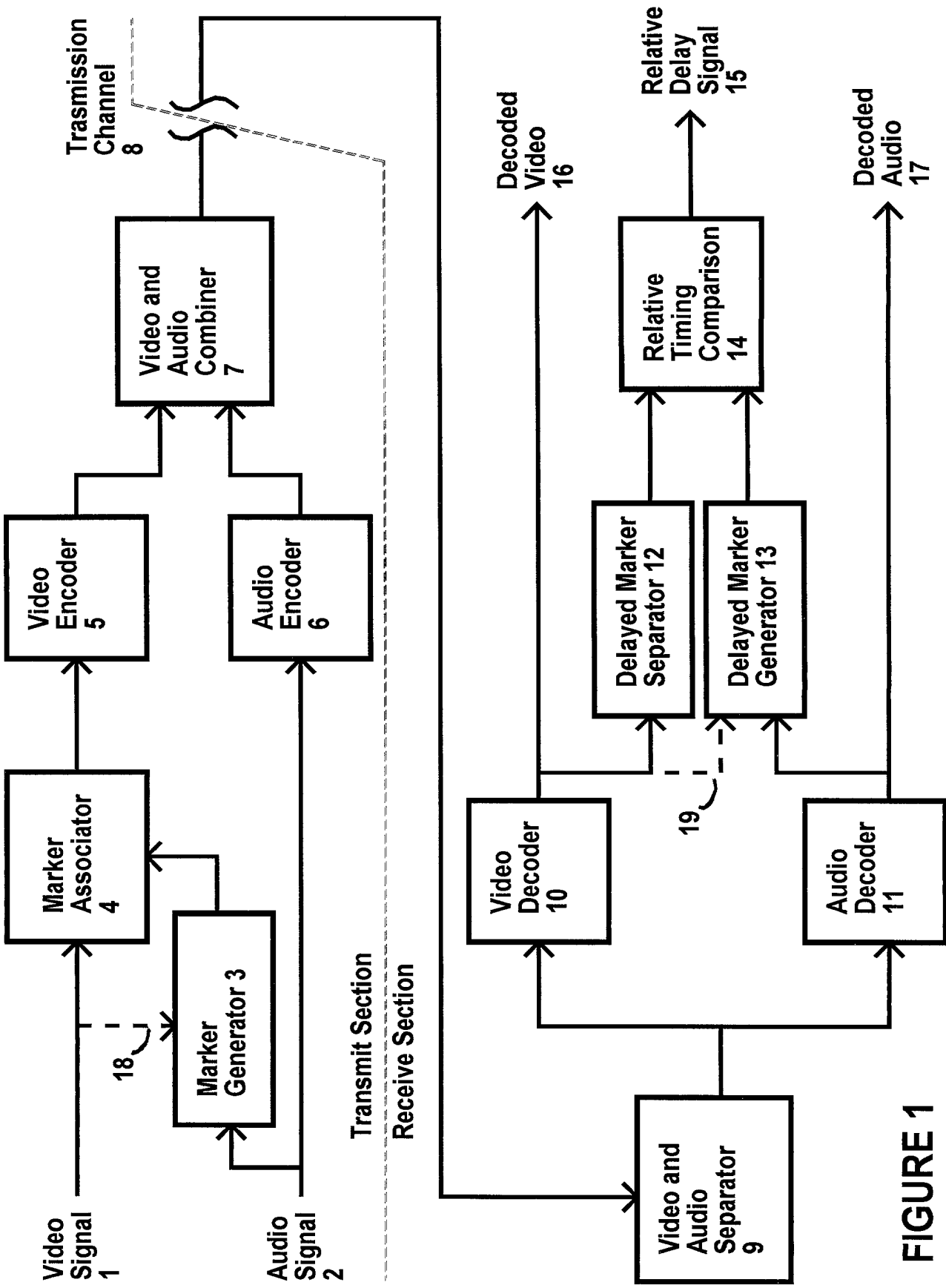


FIGURE 1

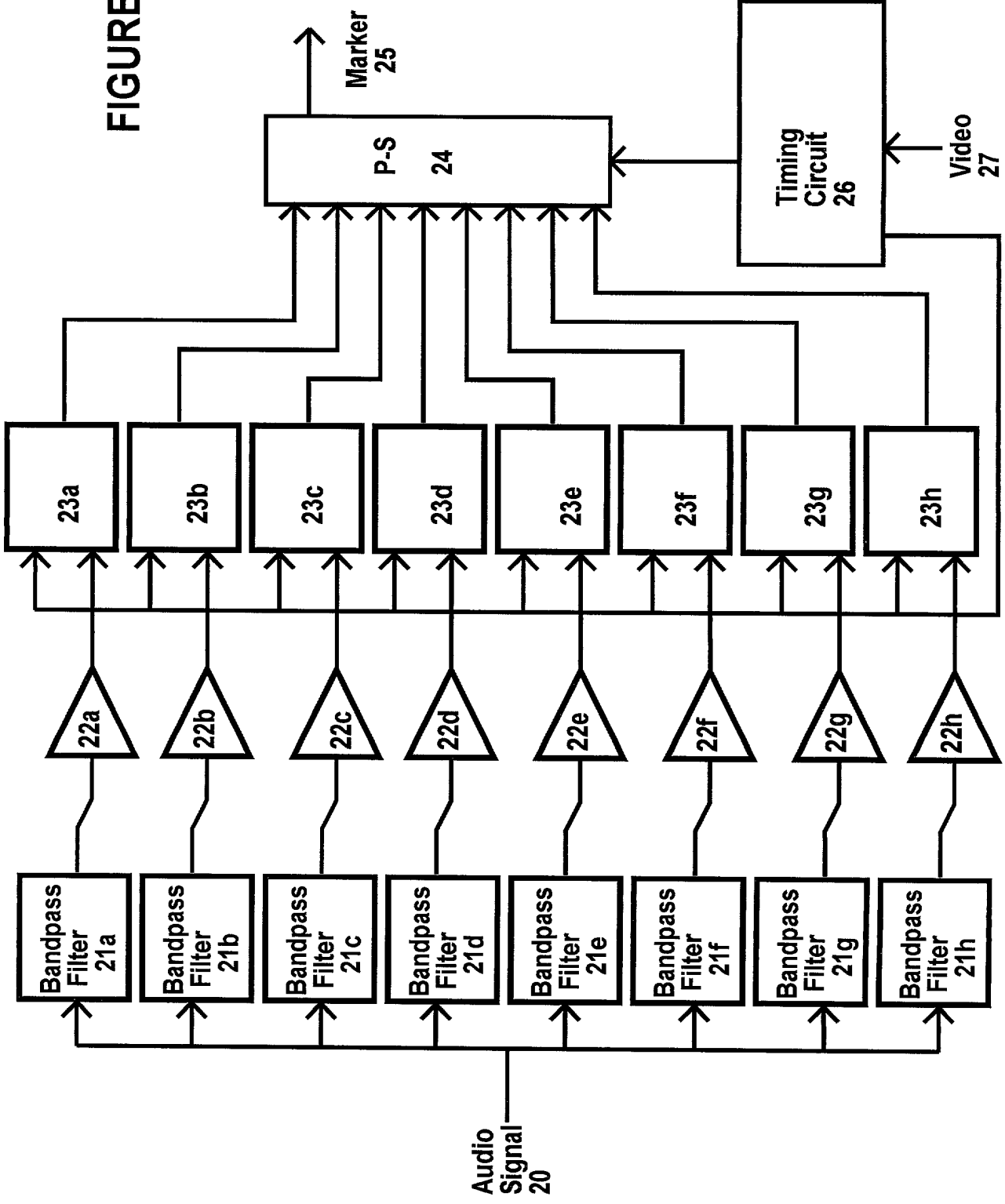


FIGURE 2

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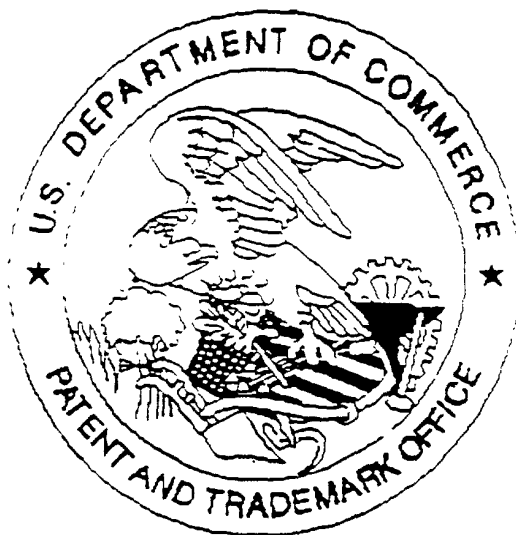
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